

Iron

Background

Iron, a mineral, is an essential micronutrient. It is in all cells of the human body and is known to have many vital functions. It is the major component of hemoglobin in red blood cells and of numerous enzymes. It carries oxygen from the lungs to all parts of the body and facilitates oxygen use and storage in muscles. Every cell in the body needs iron to produce energy. Inadequate intake and absorption of iron leads to depletion of iron stores and iron deficiency anemia.

Iron is one of the 7 key micronutrients, which the March of Dimes states have documented deficiencies causing problems for mothers and children (1). A large percentage of American women do not meet the dietary recommendations for iron. Iron deficiency has multiple negative consequences.

Adequate iron intake through a varied diet of iron rich, bioavailable foods and / or iron supplementation significantly reduces iron deficiency and iron deficiency anemia (microcytic hypochromic anemia), in which the size and number of red blood cells are reduced.

There are two forms of dietary iron, heme and nonheme. Animal flesh, blood and viscera are the main dietary sources of heme iron. Plant foods, dairy products, meat and iron salts added to foods i.e. iron fortified or iron enriched, are the main dietary sources of nonheme iron. The amount of iron absorbed and utilized (bioavailability) varies with the food source, intake of dietary inhibitors, enhancers or competitors, as well as the iron status of the individual. When iron reserves increase, iron absorption decreases. Lead is an iron competitor that should be included in the nutrition assessment of iron deficiency. Other nutrient deficiencies that may alter iron absorption and metabolism are vitamin A, folate, riboflavin and B12.

Benefits of Adequate Iron

Adequate iron intake

- Decreases fatigue and apathy
- Increases work capacity and economic productivity
- Increases ability to fight infection
- Maintains body temperature
- Decreases pica
- Improves pregnancy outcomes
 - Decreases risk of death from hemorrhage, spontaneous abortion, stress of labor and other delivery complications
 - Decreases chance of preterm delivery, low birth weight and mortality

- Improves fetal / infant health
 - May improve iron status for first 6 months
 - Decreases susceptibility to lead poisoning
 - Decreases cognitive impairment and developmental delay

Recommendations for Iron

The Dietary Reference Intake (DRI) for iron varies with age and reproductive status, including menstruation, pregnancy and lactation. It also depends on the type of iron consumed, i.e. heme or non-heme iron. The requirement for iron is 1.8 times higher for vegetarians.

Table 1
Iron
Dietary Reference Intake (DRI) (2)

DRI Dietary Reference Intake	Reproductive Status	Milligrams of Iron Per Day For 14-18 Year Old Females	Milligrams of Iron Per Day For 19-50 Year Old Females
EAR Estimated Average Requirement	Nonpregnant, menstruating	7.9	8.1
	Pregnant	23	22
	Lactating, non menstruating	7	6.5
RDA Recommended Dietary Allowance	Nonpregnant, menstruating	15	18
	Pregnant	27	27
	Lactating, non menstruating	10	9
UL Tolerable Upper Intake Level	Nonpregnant, menstruating	45	45
	Pregnant	45	45
	Lactating, non menstruating	45	45

Consequences of Excessive Iron

The Tolerable Upper Intake Level (UL) of iron is the highest level of daily iron intake, likely to have no adverse health effects on most healthy individuals. Acute iron toxicity can result from overdoses of medicinal iron. Excessive intake of iron supplements reduces zinc absorption. Women need 15 mg zinc and 2 mg copper daily when daily intake of iron exceeds 30 mg of elemental iron (3). Excessive intake of iron may also result in gastrointestinal effects such as constipation, nausea, vomiting and diarrhea. Researchers are studying cardiovascular and cancer risk associated with increased body iron stores. Hereditary hemochromatosis is characterized by excessive absorption of iron.

Reproductive Status and Iron Supplements

Throughout the perinatal period, women need to have adequate iron stores. Because dietary iron intake is often inadequate, iron supplements may be beneficial.

Table 2
Iron Recommendations for Reproductive Status

Reproductive Status	Recommendation
Nonpregnant Menstruating	<ul style="list-style-type: none">• Optimize dietary intake of iron, including iron fortified foods• Supplement with 30 mg iron per day, if iron deficient
Pregnant	<ul style="list-style-type: none">• Optimize dietary intake of iron, including iron fortified foods• Supplement with 30 mg iron per day• Treat with therapeutic iron dose, if iron deficient
Lactating Non menstruating	<ul style="list-style-type: none">• Optimize dietary intake of iron, including iron fortified foods• Treat with therapeutic iron dose, if iron deficient

Sources of Iron

Dietary iron Consuming a varied diet of iron rich foods, with iron enhancers promotes increased iron absorption. Nutritionally valuable foods that inhibit iron absorption may be included if the meal contains adequate iron absorption enhancers. Consumption of tea and coffee with meals is discouraged. Dietary iron content appears to be increased in foods prepared in cast iron and stainless steel cookware, especially in the presence of food acid. Exposure to iron competitors, primarily lead, should be eliminated.

Table 3
Dietary Iron

Type of Dietary Iron	Dietary Source	Iron Absorption Inhibitor “Blocker” (Reduce at a given meal)	Iron Absorption Enhancer “Helper” (Increase at a given meal)
Heme iron <i>High bioavailability</i> Slightly influenced by other meal components	<ul style="list-style-type: none"> • Animal flesh, blood and viscera 	<ul style="list-style-type: none"> • Dietary calcium and manganese. (Generally not a factor to consider.) 	<ul style="list-style-type: none"> • Dietary protein (Generally not a factor to consider.)
Nonheme iron <i>Low bioavailability</i> Strongly influenced by other meal components	<ul style="list-style-type: none"> • Plants, dairy products, meat and iron salts added to foods. • Iron fortified and iron enriched grains and grain products such as Product 19™, Total,™ Cream of Wheat™ • Legumes such as dried / cooked beans, peas, lentils, garbanzos, black eye peas, peanuts • Vegetables such as spinach, turnip, mustard and beet greens, yellow or green beans, peas, broccoli, sweet potato, pumpkin, potato • Fruits such as plums, figs, cherries, bananas, berries, melons • Nuts and seeds 	<ul style="list-style-type: none"> • Polyphenols such as tannins and other compounds present in foods and beverages – especially tea, coffee, chocolate and some herbal infusions • Phytic acid (phytates) in whole grains, legumes, rice • Isolated soy protein • Fiber • Calcium • Manganese 	<ul style="list-style-type: none"> • Protein / amino acids containing heme iron • Food acids which reduce dietary ferric iron to the more absorbable ferrous iron <ul style="list-style-type: none"> ○ Ascorbic acid high in citrus, tomatoes ○ Citric, malic, tartaric and lactic acid • Some fermentation products such as yeast breads

Iron Supplements

There are a variety of iron salts used in supplements. Ferrous salts are better absorbed than ferric salts.

Table 4
Elemental Iron in Common Supplements

Iron Salt	Elemental Iron Content	Required to Provide 30 mg of Iron
Ferrous sulfate	≈ 20%	150 mg
Ferrous sulfate, dry	≈ 30%	100 mg
Ferrous gluconate	≈ 12%	250 mg
Ferrous fumarate	≈ 33%	100 mg

Adapted from Drug Facts and Comparisons, Jan. 2000, p. 31

Table 5
Recommendations to take Iron Supplements

<ul style="list-style-type: none">• Take iron supplements<ul style="list-style-type: none">○ With water or juice○ At bedtime or between meals• NOTE: <i>Ascorbic acid rich juices do not increase absorption of iron from supplements in the ferrous form, but may be a preferred beverage</i>
<ul style="list-style-type: none">• Avoid taking iron supplements with<ul style="list-style-type: none">○ Milk, coffee or tea○ Calcium enriched juice / beverage○ Multiple vitamin and mineral supplement○ Calcium carbonate or magnesium oxide, i.e. some antacids
<ul style="list-style-type: none">• <i>If needed</i> to minimize gastrointestinal symptoms,<ul style="list-style-type: none">○ Begin with lower dose and increase over a period of time○ Divide doses• Take with food

Nutrition Assessment of Iron Intake

Perinatal nutrition assessment should include an iron assessment.

Table 6
Nutrition Assessment

Biochemical data: See Iron Deficiency, Tables 3,4,5,6 <ul style="list-style-type: none">• Hemoglobin or hematocrit• Mean cell volume, red blood cell distribution, width• Serum ferritin concentration
Clinical factors: <ul style="list-style-type: none">• Age• Reproductive status• Prescribed medication and/or over the counter supplements<ul style="list-style-type: none">○ Multiple / Prenatal vitamins and minerals○ Iron○ Calcium○ Antacids• Risk factors – See Iron Deficiency, Table 2
Dietary practices and patterns: <ul style="list-style-type: none">• Increase and optimize intake of iron-rich foods and foods that enhance iron absorption including<ul style="list-style-type: none">○ Iron sources, inhibitors, enhancers and competitors○ Foods and beverages – Table 3○ Supplements – Table 4,5○ Iron bioavailability○ Iron competitors, e.g. lead• Medication and meal schedule

Nutrition Education

Everyone requires iron for growth and development, health maintenance and the prevention of chronic disease. Women of childbearing age can improve both perinatal and lifelong health by ensuring adequate iron intake. See *Anemia, Iron Deficiency* for additional recommendations.

Referral

When there is an identified need for consultation, assessment, intervention, therapy or resources, refer to the appropriate health care professionals, who have expertise in nutrition and health. Multidisciplinary interventions contribute to improved short term and long term health outcomes.

Resources

Useful web sites

- Center for Disease Control www.cdc.gov
 - Iron Deficiency in the United States
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5140a1.htm#top>
 - Recommendations to Prevent and Control Iron Deficiency Anemia
<http://www.cdc.gov/mmwr/preview/mmwrhtml/00051880.htm>
- USDA database for iron content of food
<http://www.nal.usda.gov/fnic/foodcomp/Data/SR16/wtrank/sr16a303.pdf>

References

1. March of Dimes. Nutrition today matters tomorrow: A report from the March of Dimes task force on nutrition and optimal human development. 2002.
2. Institute of Medicine, Food and Nutrition Board. Iron. In: Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc. Washington DC: National Academy Press; 2001. p. 290-393.
3. Institute of Medicine, Food and Nutrition Board. Nutrition during pregnancy. Washington D.C.; 1990. p. 305-307.

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